भारतीय मानक
Indian Standard

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(Reaffirmed 2020)

वेल्ड के चुम्बकीय कण द्वारा दोष निकालने हेतू — रीति संहिता

(तीसरा पुनरीक्षण)

Magnetic Particle Flaw Detection of Welds — Code of Practice

(Third Revision)

ICS 25.160.40; 77.040.20

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Non-destructive Testing Sectional Committee, MTD 21

FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Non-destructive Testing Sectional Committee had been approved by the Metallurgical Engineering Division Council (MTDC).

This standard was first published in 1971 and subsequently revised in 1981 and 2003. While reviewing this standard in the light of experience gained during these years, the Committee felt the need to revise this standard. While revising this standard International practices have been duly considered along with Indian scenario.

In this revision following modifications have been carried out:

a) Method of magnetization has been revised by adding new clauses.
b) Adequacy of magnetization has been added.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

MAGNETIC PARTICLE FLAW DETECTION OF WELDS — CODE OF PRACTICE

(Third Revision)

1 SCOPE

1.1 This standard prescribes the recommended procedure for detection of surface and sub-surface discontinuities in welds by the magnetic particle inspection method. The method is applicable only to materials in which the weld metal is ferromagnetic.

1.2 This standard does not lay down any requirements for the acceptance or rejection of welds which shall be the subject of mutual agreement between the contracting parties. This agreement may provide details with regard to:

a) welds or sections of welds to be inspected,
b) techniques to be used,
c) type of discontinuities to be accepted, and
d) re-working and subsequent retesting which may be permissible.

2 REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

IS No.	*Title*
3415 : 1998	Glossary of terms used in magnetic particle flaw detection (*second revision*)
3703 : 2004	Code of practice for magnetic particle flaw detection (*second revision*)
13805 : 2004	Guidelines for certification for personnel for non-destructive testing

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 3415 shall apply.

4 PRINCIPLE OF METHOD

This method of flaw detection consists of magnetizing the weld and the heat affected zone, applying magnetic particles to the surface and observing the particle pattern. The particles retained on the surface due to the leakage field form patterns that are characteristic of the type of flaws present. This method is suitable for surface and sub-surface flaws only and is not suitable for deep-seated flaws, since the sensitivity decreases sharply with the depth of location of the flaws.

5 SURFACE CONDITION

The surface to be examined shall be clean, dry and free from rust, oil, scale, excessive slag and other extraneous matter which may interfere with the sensitivity of examination. In general, satisfactory results may be obtained when the surface is in the as welded condition. However, rough surfaces hamper the mobility of magnetic particles due to mechanical trapping which in turn produces false indications. In such cases, surface preparation by wire brushing, shot blasting and grit blasting, machining or any other suitable method is necessary. To reveal fine defects, the surfaces to be inspected should be smooth machined to at least a 6.3 microns finish. However, a thin layer of paint of 0.05 mm maximum thickness does not interfere with the formation of indications, but must be removed at points where electrical contact is to be made.

6 TYPES OF PARTICLES

Magnetic particles used for detection of flaws may be of the dry or wet type in either visible (colour contrast) or fluorescent form.

6.1 If dry particles are used as the examination medium, they shall be of high magnetic permeability and low magnetic retentivity and shall be of such size and shape as will produce suitable indications. It is desirable that the colour be such as to provide adequate contrast with the background of the surface being examined.

6.2 If wet particles are used, the particles shall be red, black, grey or yellow, or of fluorescent type when viewed under ultraviolet illumination. These particles would be suspended in a liquid medium, the bath strength of which shall be as given in IS 3703. The bath shall be thoroughly stirred and the strength

(concentration) and condition checked at frequent intervals.

6.3 The dry powder method is more sensitive than the wet method in the detection of near surface discontinuities, but is less sensitive in detecting fine surface discontinuities. It is also convenient to use in conjunction with portable equipment for the inspection of large areas or for field operation. It is, therefore, often used for the examination of heavy weldments and parts with rough surfaces. In comparison, wet method is good for parts with rough surfaces and for parts which are small in size and tested with stationary equipment.

7 METHODS OF MAGNETIZATION

A suitable and appropriate means for establishing the necessary magnetic flux in the job, as described below, may be used.

7.1 Local Circular Magnetization (or Prod Magnetization)

7.1.1 Local circular magnetization is achieved by the use of portable prod type electrical contacts pressed against the surface in the area to be examined (*see* Fig. 1).

7.1.2 The prod spacing is usually kept between 150-200 mm. Shorter spacing may be used to meet the limitation of geometry and dimensions of area being examined, or to increase the sensitivity, but prod spacing less than 50 mm is not recommended as it will result into banding of the particles around the prods.

7.1.3 Alternating or one half wave rectified magnetizing current shall be used. The current shall be selected as below (*see* Fig. 1) depending upon the thickness of the jobs being tested.

7.1.4 A suitable instrument shall be used to measure the current. The equipment shall be calibrated periodically once in a year or immediately after it has undergone major overhaul to ensure that the equipment has the required sensitivity and delivers the specified current as shown by the ammeter.

7.1.5 In order to avoid damage as a result of burning and to improve the contact efficiency, both test material and the tip of the electrode must be kept well ground. If necessary, electrodes may be provided with contact pads. Elimination of arcing is very important for testing high carbon steels and alloy steels as this can cause hard spots or cracks.

7.1.6 To eliminate arcing, magnetizing current should not be turned on until after the prods have been properly positioned in contact with the surface and the current shall be turned off before the prods are removed. For this purpose it is further desirable to have a remote control switch built into the prod handles.

7.1.7 Lead or steel-tipped rather than copper-tipped prods are recommended where the magnetizing voltage is over 25 V, in order to avoid copper penetration.

7.1.8 For circular magnetization of complete parts having a weld as an integral part using stationary type equipment the following methods of magnetization may also be used.

a) Direct current of head shot method.
b) Central conductor method of magnetization

7.1.8.1 The current level is for the above method shall

Thickness Range	*Current Requirement per 25 mm* of Prod Spacing
Under 20 mm	90 to 110 ampere
20 mm and over	100 to 125 ampere

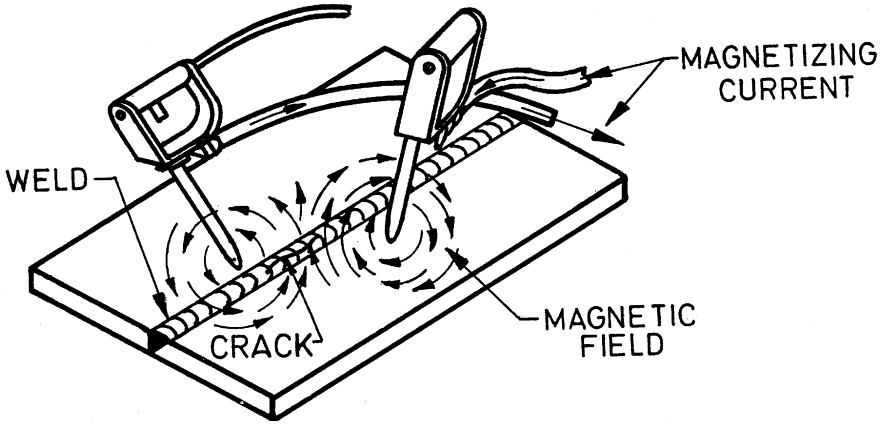

FIG. 1 PROD MAGNETIZATION

be 300 to 800 Amp per inch of port diameter (*D*) of the part shall be taken as the greatest distance between any two points on the outside circumferences of the part.

7.1.8.2 For circular magnetization using offset central conductor where the contactor inside the part is towards the inside wall of the part the current level in **7.1.8.1** shall apply except that the total diameter (*D*) shall be taken as the sum of the diameter of central conductor added to twice the wall thickness of the part.

7.2 Longitudinal Magnetization (Yoke Method)

7.2.1 Alternating current electromagnetic yokes shall be used provided the sensitivity to detect surface cracks is at least equivalent to that of the prod when a direct or rectified magnetizing current of 25 to 30 A/25 mm of prod spacing is used and the lifting power of yoke is at least 5 kg with a pole spacing of 75-150 mm.

7.2.2 Alternatively direct current electromagnet or permanent magnet yoke may be used if it has got a lifting power of 20 kg with a pole spacing of 75-150 mm, other conditions remaining the same.

7.3 A suitable instrument, such as magnetic field indicator, as shown in Fig. 2 should be used, whenever necessary, to establish the adequacy of magnetic field. The indicator should be positioned on the weld being examined while applying the required current and ferromagnetic particles. The formulation of particles indicates that adequate field strength has been generated in the welding to be examined. When a clearly defined pattern of particles is not formed, or not formed in the desired direction, the magnetizing technique shall be changed or adjusted to obtain it.

7.3.1 For longitudinal magnetization of weld which forms an integral part of a component using stationery type equipment the coil magnetization method may be employed.

7.4 Direction of Magnetization

Since proper indications are obtained, when the discontinuities are perpendicular to the direction of magnetic field, at least two seperate examinations shall be carried out on each area. The prod or yoke shall be placed such that the magnetic field during one case is approximately perpendicular to that during the other.

7.5 Examination shall be done by the continuous method, that is, the magnetization current must remain on while the examination medium is applied and while excess of examination medium is being removed. Residual method shall be used only if approved by the purchaser.

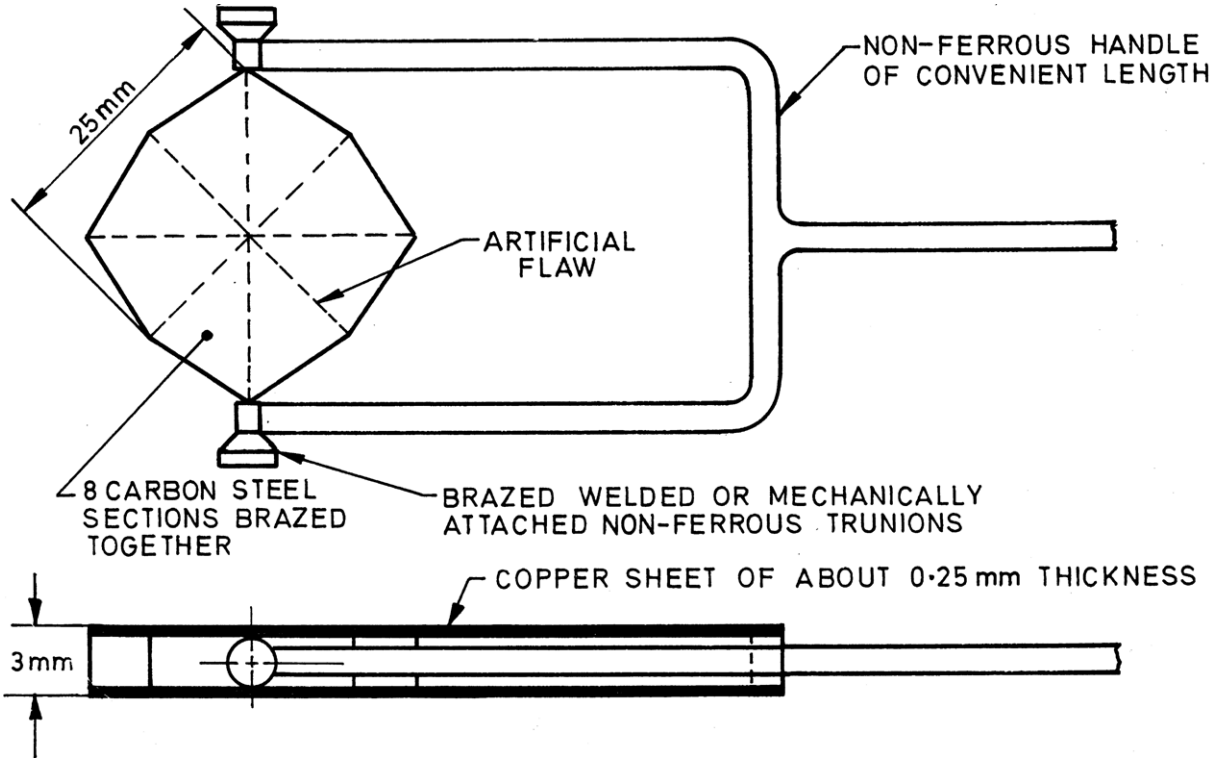

FIG. 2 MAGNETIC FIELD INDICATOR

7.6 Examination shall be conducted with sufficient overlap to ensure cent percent coverage.

7.7 For the examination of welds, care must be taken on the following items:

a) When the heat treatment is done on a welded part after welding, the examination for the determination of acceptance or otherwise shall be conducted after heat treatment; and

b) The magnetic particle examination after heat treatment of welded part, of after completion of pressure test of pressure vessel shall, as a rule, be of yoke type.

7.8 Adequacy of Magnetic Field

A suitable instrument such as magnetic field indicator, as shown in Fig. 2 should be used whenever necessary to establish the adequacy of magnetic field. The indicator should be positioned on the weld being examined while applying the required current and ferromagnetic particles. The formulation of particles indicates that adequate field strength has been generated in the welding to be examined.

7.8.1 The adequacy of magnetic field may also be established by any one of the following means in conjunction with either given below.

a) Using Pie field indicator as specified in **7.8**,

b) Using slotted shims,

c) Using tangential field hall eject gauss meter. The tangentional field strength shall have a minimum valve of 30G (2.5 KA/M)

8 APPLICATION OF MAGNETIC PARTICLES

The magnetic particles shall be applied immediately prior to the application of magnetizing current or while the magnetizing current is on by spraying the liquid suspension, or by lightly dusting dry powder over the job. An applicator may be used for rapid and uniform application of dry powder and any excess powder may be removed with a gentle air stream. The air system should not disturb or remove lightly held particle patterns. In order to recognize the broad, fuzzy indication it is essential to observe carefully the formation of indications, while the particles are being applied and also while any excess is being removed. Proper lighting will facilitate the observation of these patterns. The temperature of the dry particles and of the surface of the part shall not exceed the Curie temperature 315°C.

9 EXAMINATION

9.1 Discontinuities are indicated by retention of the magnetic particles.

9.2 The lighting used for the purpose shall be adequate without creating shadows and highlights. During visible magnetic particle inspection the intensity of the visible light at the surface shall be minimum 1 000 lux. When using fluorescent powders, the inspection area should be darkened. The intensity of ambient visible light in the darkened should not exceed 20 lux. Black light provided with filter to pass mainly near ultraviolet rays of (3 300-3 900°A) and having the strength to discriminate the fluorescent magnetic particle indications shall be used.

9.3 A low powered optical magnifier is a desirable inspection aid, particularly when very small flaws are to be examined.

9.4 Flaws requiring repair or investigation should be marked out clearly using grease, pencil, coloured, crayon or paint.

9.5 Permanent record can also maintained in written form by recording location, length, orientation, number and type of indications.

10 ASSESSMENT OF FLAWS

10.1 If the indication is caused by the surface discontinuities, the particles are usually tightly held to the surface by a relatively strong magnetic field. The line of particles shall be sharp and well defined. But, if the indication is caused by sub-surface discontinuity, the particles are held in a broad fuzzy accumulation rather than in sharp and well defined patterns.

10.2 Relevant indications are those which results from mechanical discontinuities.

10.3 Non-relevant indications are caused by distortion of magnetic field resulting from magnetic writing, cold working, hard and soft spots, boundaries of heat affected zones, abrupt change of section, etc. Care shall be taken to identify and eliminate them, as they may mask the actual defects.

10.4 Any indication suggested to be non-relevant is to be considered relevant till it is proved otherwise.

10.5 Broad areas of particle accumulation which could mask indications of discontinuities are unacceptable and these areas shall be cleaned and re-examined.

10.6 Linear indications are those in which the length is more than three times the width.

10.7 Rounded indications are those which are circular or elliptical with the length less than three times the width.

11 DEMAGNETIZATION

11.1 Demagnetization is unnecessary unless the residual field interferes with subsequent machining, arc-welding operations, or with structures, such as aircraft, where sensitive electrical instruments may be

affected by the residual magnetic field.

11.2 Demagnetization, if required, shall be clearly specified in drawing/purchase orders. The level of residual magnetism and the measuring method shall also be specified.

12 PROTECTION

Since the weld had been cleaned prior to magnetic particle inspection, it is liable to rusting unless protected. Temporary corrosion protectives may be applied over the component after magnetic particle inspection.

13 RECORD OF TEST DATA

Magnetic particle flaw detection of welds shall be carried out by qualified personnel (*see* IS 13805).

13.1 The following data shall be recorded at the time of each test for further reference:

a) Name and reference number of the part;
b) material sectional thickness, type of weld;
c) method used, dry or wet;
d) type of magnetization;
e) type of current;
f) amount of current;
g) location and nature of defects;
h) details of the machine;
j) name and certification level of the operator conducting the test; and
k) other information, if necessary.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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